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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: TAKE Kazuhiko et al.
SERIAL NO.: NEW U.S. PCT APPLICATION
FILED: HEREWITH
INTERNATIONAL APPLICATION NO.: PCT/JP99/06943
INTERNATIONAL FILING DATE: December 10, 1999
FOR: PIPERAZINE DERIVATIVES

REQUEST FOR PRIORITY UNDER 35 U.S.C. 119 AND THE INTERNATIONAL CONVENTION

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

In the matter of the above-identified application for patent, notice is hereby given that the applicant claims as priority:

COUNTRY	APPLICATION NO	DAY/MONTH/YEAR
Australia	PP7706	14 December 1998
Australia	PQ3568	21 October 1999

Certified copies of the corresponding Convention application(s) were submitted to the International Bureau in PCT Application No. PCT/JP99/06943. Receipt of the certified copy(s) by the International Bureau in a timely manner under PCT Rule 17.1(a) has been acknowledged as evidenced by the attached PCT/IB/304.

Respectfully submitted,
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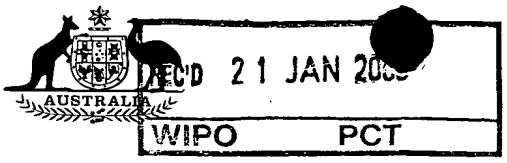

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Patent Office
Canberra

I, LEANNE MYNOTT, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PP 7706 for a patent by FUJISAWA PHARMACEUTICAL CO., LTD. filed on 14 December 1998.

WITNESS my hand this
Sixth day of December 1999

L.M.

LEANNE MYNOTT
TEAM LEADER EXAMINATION
SUPPORT AND SALES

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Regulation 3.2

Fujisawa Pharmaceutical Co., Ltd.

A U S T R A L I A
Patents Act 1990

PROVISIONAL SPECIFICATION
for the invention entitled:

"Piperazine Derivatives"

The invention is described in the following statement:

D E S C R I P T I O N

PIPERAZINE DERIVATIVES

TECHNICAL FIELD

The present invention relates to new piperazine derivatives and a salt thereof.

More particularly, it relates to new piperazine derivatives and a salt thereof which have pharmacological activities such as Tachykinin antagonism, especially Substance P antagonism, Neurokinin A antagonism, Neurokinin B antagonism, and the like, to a process for preparation thereof, to a pharmaceutical composition comprising the same, and to a use of the same as a medicament.

Accordingly, one object of the present invention is to provide new and useful piperazine derivatives and a salt thereof which have pharmacological activities such as Tachykinin antagonism, especially Substance P antagonism, Neurokinin A antagonism, Neurokinin B antagonism, and the like.

Another object of the present invention is to provide a process for the preparation of said piperazine derivatives and a salt thereof.

A further object of the present invention is to provide a pharmaceutical composition comprising, as an active ingredient, said piperazine derivatives and a pharmaceutically acceptable salt thereof.

Still further object of the present invention is to provide a use of said piperazine derivatives or a pharmaceutically acceptable salt thereof as Tachykinin antagonist, especially Substance P antagonist, Neurokinin A antagonist or Neurokinin B antagonist, useful for treating or preventing Tachykinin-mediated diseases, for example, respiratory diseases such as asthma, bronchitis, rhinitis, couph, expectoration, and the like; ophthalmic diseases such

alkyl, (lower)alkoxy(lower)alkylmorpholinyl(lower)alkyl or (lower)alkoxy(lower)alkylmorpholinylcarbonyl(lower)-alkyl;

piperidylmethyl;

piperidyl(lower)alkyl which is substituted with lower alkyl or (lower)alkoxy(lower)alkyl;

(2,6-dimethylmorpholino)(lower)alkyl;

(3,3-dimethylmorpholino)(lower)alkyl;

(cis-3,5-dimethylmorpholino)(lower)alkyl;

((3S,5S)-3,5-dimethylmorpholino)(lower)alkyl;

(2-methoxymethylmorpholino)(lower)alkyl;

(3-methoxymethylmorpholino)(lower)alkyl;

(2-methoxymethyl-5-methylmorpholino)(lower)alkyl;

(2-methoxymethyl-5,5-dimethylmorpholino)(lower)alkyl;

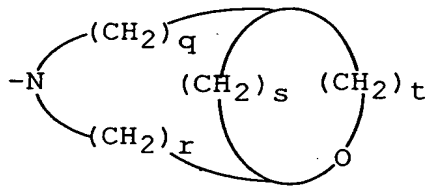
(3,5-dimethoxymethylmorpholino)(lower)alkyl;

(2,3-dimethoxymethylmorpholino)(lower)alkyl;

(2-methoxymethylmorpholino)(lower)alkenyl;

(5,6,7,8-tetrahydro-1,6-naphthyridin-6-yl)(lower)alkyl;

or lower alkyl which is substituted with a saturated heterocyclic group of the formula :



(wherein r, s and t are each integer of 1 to 2, and q is integer of 0 to 2)

which may be substituted with one or two lower alkyl.

It is to be noted that the object compound (I) may include one or more stereoisomers due to asymmetric carbon atom(s) and double bond, and all of such isomers and a mixture thereof are included within the scope of the present invention.

It is further to be noted that isomerization or rearrangement of the object compound (I) may occur due to the

W_1 is a leaving group.

As to the starting compounds (II) and (III), some of them are novel and can be prepared by the procedures described in the Preparations and Examples mentioned later or similar manners thereto.

Suitable salts of the starting and object compounds are conventional non-toxic and pharmaceutically acceptable salt and include an acid addition salt such as an organic acid salt (e.g. acetate, trifluoroacetate, fumarate, maleate, tartrate, methanesulfonate, benzenesulfonate, formate, toluenesulfonate, etc.), an inorganic acid salt (e.g. hydrochloride, hydrobromide, hydroiodide, sulfate, nitrate, phosphate, etc.), or a salt with an amino acid (e.g. arginine, aspartic acid, glutamic acid, etc.), or a metal salt such as an alkali metal salt (e.g. sodium salt, potassium salt, etc.) and an alkaline earth metal salt (e.g. calcium salt, magnesium salt, etc.), an ammonium salt, an organic base salt (e.g. trimethylamine salt, triethylamine salt, pyridine salt, picoline salt, dicyclohexylamine salt, N,N'-dibenzylethylenediamine salt, etc.), or the like.

In the above and subsequent descriptions of the present specification, suitable examples and illustrations of the various definitions which the present invention intends to include within the scope thereof are explained in detail as follows.

The term "lower" is intended to mean 1 to 6, preferably 1 to 4, carbon atom(s), unless otherwise indicated.

Suitable "lower alkylene" may include straight or branched one having 1 to 6 carbon atom(s), such as methylene, ethylene, trimethylene, propylene, tetramethylene, methylmethylene, methyltrimethylene, hexamethylene, and the

the most preferred one is methoxy.

Suitable "substituent" in the terms "aryl which may be substituted with suitable substituent(s)" for R^1 and "aryl or indolyl, each of which may be substituted with suitable substituent(s)" for R^2 may include lower alkyl (e.g., methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tert-butyl, pentyl, neopentyl, tert-pentyl, hexyl, etc.), lower alkylenedioxy (e.g., methylenedioxy, ethylenedioxy, propylenedioxy, etc.), lower alkoxy (e.g., methoxy, ethoxy, propoxy, isopropoxy, isobutoxy, tert-butoxy, pentyloxy, neopentyloxy, tert-pentyloxy, hexyloxy, etc.), lower alkoxy(lower)alkoxy(lower)alkoxy (e.g., (2-methoxyethoxy)-methoxy, etc.), mono(or di or tri)halo(lower)alkyl (e.g., fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl, bromomethyl, dibromomethyl, tribromomethyl, 1 or 2-fluoroethyl, 1 or 2-bromoethyl, 1 or 2-chloroethyl, 1,1-difluoroethyl, 2,2-difluoroethyl, etc.), halogen (e.g., chlorine, bromine, fluorine and iodine), hydroxy, hydroxy(lower)alkyl (e.g., hydroxymethyl, hydroxyethyl, 1-hydroxy-1-methylethyl, etc.), cyano, lower alkylthio (e.g., methylthio, ethylthio, propylthio, isopropylthio, butylthio, etc.), lower alkylsulfonyl (e.g., methylsulfonyl, ethylsulfonyl, propylsulfonyl, isopropylsulfonyl, butylsulfonyl, etc.), di(lower alkyl)aminosulfonyl (e.g., dimethylaminosulfonyl, diethylaminosulfonyl, etc.), pyrrolidinyl (e.g., 2-pyrrolidinyl, 3-pyrrolidinyl, pyrrolidino, etc.), morpholinyl (e.g., 2-morpholinyl, 3-morpholinyl, morpholino which may be substituted with lower alkyl as mentioned above or lower alkoxy(lower)alkyl (e.g., methoxymethyl, ethoxymethyl, 1-methoxyethyl, 2-methoxyethyl, 1-ethoxyethyl, 2-ethoxyethyl, etc.), pyrrolyl (e.g., 1-pyrrolyl, 2-pyrrolyl, 3-pyrrolyl, etc.), pyridyl (e.g., 2-pyridyl, 3-pyridyl, 4-pyridyl, etc.), and the like.

isopropyl), mono(or di or tri)halo(lower)alkyl (more preferably mono(or di or tri)halo(C_1-C_4)alkyl, most preferably difluoromethyl or trifluoromethyl), halogen (more preferably chlorine or fluoride), lower alkylenedioxy (more preferably C_1-C_4 alkylenedioxy, most preferably methylenedioxy or ethylenedioxy), lower alkoxy(lower)alkoxy(lower)alkoxy (more preferably C_1-C_4 alkoxy(C_1-C_4)alkoxy(C_1-C_4)alkoxy, most preferably (2-methoxyethoxy)methoxy), hydroxy, hydroxy(lower)alkyl (more preferably hydroxy(C_1-C_4)alkyl, most preferably hydroxymethyl or 1-hydroxy-1-methylethyl), cyano, pyrrolidinyl (more preferably pyrrolidino) and morpholinyl (more preferably morpholino) which may be substituted with lower alkoxy(lower)alkyl (more preferably C_1-C_4 alkoxy(C_1-C_4)alkyl, most preferably methoxymethyl) or lower alkyl (more preferably C_1-C_4 alkyl, most preferably methyl)];

R^3 is hydrogen; and

R^4 is (3-pyridyl)methyl;

(3-pyridyl)ethyl (more preferably 2-(3-pyridyl)ethyl);

3-(3-pyridyl)propyl;

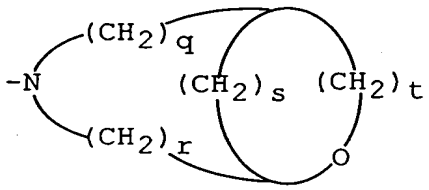
3-(3-pyridyl)propenyl (more preferably 3-(3-pyridyl)-2-propenyl);

3-(3-pyridyl)propynyl (more preferably 3-(3-pyridyl)-2-propynyl);

pyrazolylmethyl (more preferably (4-pyrazolyl)methyl or (5-pyrazolyl)methyl) which may be substituted with hydroxy(lower)alkyl (more preferably hydroxy(C_1-C_4)-alkyl, most preferably 2-hydroxyethyl);

pyrazolyl(lower)alkyl (more preferably pyrazolyl-(C_1-C_4)alkyl, most preferably (4-pyrazolyl)methyl, (5-pyrazolyl)methyl or 3-(4-pyrazolyl)propyl) which is substituted with lower alkyl (more preferably C_1-C_4 alkyl, most preferably methyl), (lower)alkoxy(lower)-alkylmorpholinyl(lower)alkyl (more preferably (C_1-C_4)-

preferably (2-methoxymethyl-5-methylmorpholino)-(C_1-C_4)alkyl, most preferably 2-(2-methoxymethyl-5-methylmorpholino)ethyl);
(2-methoxymethyl-5,5-dimethylmorpholino)(lower)alkyl (more preferably (2-methoxymethyl-5,5-dimethylmorpholino)(C_1-C_4)alkyl, most preferably 2-(2-methoxymethyl-5,5-dimethylmorpholino)ethyl);
(3,5-dimethoxymethylmorpholino)(lower)alkyl (more preferably (3,5-dimethoxymethylmorpholino)(C_1-C_4)alkyl, most preferably 2-(3,5-dimethoxymethylmorpholino)ethyl);
(2,3-dimethoxymethylmorpholino)(lower)alkyl (more preferably (2,3-dimethoxymethylmorpholino)(C_1-C_4)alkyl, most preferably 2-(2,3-dimethoxymethylmorpholino)ethyl);
(2-methoxymethylmorpholino)(lower)alkenyl (more preferably (2-methoxymethylmorpholino)(C_2-C_4)alkenyl, most preferably 4-(2-methoxymethylmorpholino)-2-butenyl);
(5,6,7,8-tetrahydro-1,6-naphthyridin-6-yl)(lower)alkyl (more preferably (5,6,7,8-tetrahydro-1,6-naphthyridin-6-yl)(C_1-C_4)alkyl, most preferably 2-(5,6,7,8-tetrahydro-1,6-naphthyridin-6-yl)ethyl); or
lower alkyl (more preferably C_1-C_4 alkyl, most preferably ethyl) which is substituted with a saturated heterocyclic group of the formula :



(wherein
r, s and t are each integer of 1 to 2, and
q is integer of 0 to 2)
(more preferably (1S,4S)-2-aza-5-oxabicyclo[2.2.1]-heptan-2-yl) which may be substituted with one or two lower alkyl (more preferably C_1-C_4 alkyl, most preferably methyl).

phenyl, [hydroxy(lower)alkyl](hydroxy)phenyl, (cyano)(hydroxy)phenyl, (dihalo(lower)alkyl)(hydroxy)-phenyl, (lower alkyl)(hydroxy)phenyl, (lower alkyl)(pyrrolidinyl)phenyl, (lower alkyl)(morpholinyl)phenyl, (lower alkyl)[(lower)alkoxy-(lower)alkylmorpholinyl]phenyl or (lower alkyl)[(lower alkyl)morpholinyl]phenyl, most preferably 1,4-benzodioxan-6-yl, 4-fluorophenyl, 4-trifluorophenyl, 4-fluoro-3-methylphenyl, 3-fluoro-4-methylphenyl, 4-chloro-3-hydroxyphenyl, 3-hydroxy-4-trifluoromethylphenyl, 3-hydroxy-4-hydroxymethylphenyl, 3-hydroxy-4-(1-hydroxy-1-methylethyl)phenyl, 4-cyano-3-hydroxyphenyl, 3-hydroxy-4-difluoromethyl-phenyl, 3-hydroxy-4-isopropylphenyl, 4-methyl-3-pyrrolidinophenyl or 4-methyl-3-morpholinophenyl] or indolyl;

R^3 is hydrogen; and

R^4 is (2,6-dimethylmorpholino)(lower)alkyl (more preferably (2,6-dimethylmorpholino)(C_1-C_4)alkyl, most preferably 2-(2,6-dimethylmorpholino)ethyl);

(3,3-dimethylmorpholino)(lower)alkyl (more preferably (3,3-dimethylmorpholino)(C_1-C_4)alkyl, most preferably 2-(3,3-dimethylmorpholino)ethyl);

(cis-3,5-dimethylmorpholino)(lower)alkyl (more preferably (cis-3,5-dimethylmorpholino)(C_1-C_4)alkyl, most preferably 2-(cis-3,5-dimethylmorpholino)ethyl);

((3S,5S)-3,5-dimethylmorpholino)(lower)alkyl (more preferably ((3S,5S)-3,5-dimethylmorpholino)(C_1-C_4)alkyl, most preferably 2-((3S,5S)-3,5-dimethylmorpholino)-ethyl);

(2-methoxymethylmorpholino)(lower)alkyl (more preferably (2-methoxymethylmorpholino)(C_1-C_4)alkyl, most preferably 3-(2-methoxymethylmorpholino)propyl or 2-(2-methoxymethylmorpholino)ethyl);

(3-methoxymethylmorpholino)(lower)alkyl (more preferably

of the compound (II) with a silyl compound such as bis(trimethylsilyl)acetamide, mono(trimethylsilyl)acetamide, bis(trimethylsilyl)urea or the like; a derivative formed by reaction of the compound (II) with phosphorus trichloride or phosgene and the like.

The reaction is usually carried out in a conventional solvent such as water, alcohol [e.g. methanol, ethanol, etc.], acetone, dioxane, acetonitrile, chloroform, methylene chloride, ethylene chloride, tetrahydrofuran, ethyl acetate, N,N-dimethylformamide, pyridine or any other organic solvent which does not adversely influence the reaction. These conventional solvents may also be used in a mixture with water.

The reaction may also be carried out in the presence of an inorganic or organic base such as alkali metal carbonate, alkali metal bicarbonate, tri(lower)alkylamine, pyridine, N-(lower)alkylmorpholine, N,N-di(lower)alkylbenzylamine, or the like.

The reaction temperature is not critical, and the reaction is usually carried out under cooling to heating.

Process 2

The object compound (Ib) or a salt thereof can be prepared by subjecting the compound (Ia) or a salt thereof to a reduction reaction.

The reaction can be carried out in the manner disclosed in Example 8 mentioned later or similar manners thereto.

The object compound (I) and a pharmaceutically acceptable salt thereof have pharmacological activities such as Tachykinin antagonism, especially Substance P antagonism, Neurokinin A antagonism or Neurokinin B antagonism, and therefore are useful for treating or preventing Tachykinin-mediated diseases, particularly Substance P-mediated diseases, for example, respiratory diseases such as asthma,

psoriasis; inflammatory intestinal diseases, particularly Crohn's diseases; hepatitis; superficial pain on congelation, burn, herpes zoster or diabetic neuropathy; telalgia attended to hyperlipidemia; postoperative neuroma, particularly of mastectomy; vulvar vestibulitis; hemodialysis-associated itching; lichen planus; laryngopharyngitis; bronchiectasis; coniosis; whooping cough; pulmonary tuberculosis; cystic fibrosis; emesis (e.g., nausea, retching, vomiting, acute emesis, delayed emesis, anticipatory emesis, past operative nausea and vomiting (PONV), acute and/or delayed emesis induced by drugs such as cancer chemotherapeutic agents, etc.); mental diseases, particularly anxiety, depression, dysthymic disorders and schizophrenia; demyelinating diseases such as multiple sclerosis and amyotrophic lateral sclerosis; attenuation of morphine withdrawal; oedema, such as oedema caused by thermal injury; small cell carcinomas, particularly small cell lung cancer (SCLC); hypersensitivity disorders such as poison ivy; fibrosing and collagen diseases such as scleroderma and eosinophilic fascioliasis; reflex sympathetic dystrophy such as shoulder/hand syndrome; addiction disorders such as alcoholism; stress related somatic disorders; rheumatic diseases such as fibrositis; and the like.

Furthermore, the object compound (I) and a pharmaceutically acceptable salt thereof of the present invention are Central Nervous System (CNS) penetrant.

For therapeutic purpose, the compound (I) and a pharmaceutically acceptable salt thereof of the present invention can be used in a form of pharmaceutical preparation containing one of said compound, as an active ingredient, in admixture with a pharmaceutically acceptable carrier such as an organic or inorganic solid or liquid excipient suitable for oral, parenteral, external including topical, enternal, intravenous, intramuscular, inhalant, nasal, intraarticular, intraspinal, transtracheal or transocular administration.

distilled water by using Polytoron (KINEMATICA). To extract the test compound, 500 µl of the homogenate, 100 µl of methanol, 500 µl of 0.1 N NaOH and 4 ml of ethyl acetate were mixed by shaking for 10 min at room temperature. The organic phase (2.5 ml) was recovered by centrifugation at 3,000 rpm for 10 min, dried and dissolved in dimethyl sulfoxide.

(2) h-NK_1 receptor binding assay

(a) Crude CHO cell membrane preparation

CHO cells permanently expressing h-NK_1 receptors were harvested and homogenized with a Dounce homogenizer at 4°C in a buffer (0.25 M sucrose, 25 mM Tris-HCl (pH 7.4), 10 mM $MgCl_2$, 1 mM EDTA, 5 µg/ml p-APMSF). The homogenate was centrifuged (500 x g, 10 min), and the pellet was resuspended in the same buffer, homogenized, and centrifuged. The two supernatants were combined and centrifuged (100,000 x g, 1 hour). The crude cell membranes thus isolated were resuspended in a buffer (25 mM Tris-HCl (pH 7.4), 10 mM $MgCl_2$, 1 mM EDTA, 5 µg/ml p-APMSF) and stored at -80° until use.

(b) ^{125}I-BH-Substance P binding to the prepared membrane

Cell membranes (6 µg/ml) were incubated with ^{125}I-BH-Substance P (0.1 nM) with or without the extracted compounds in 0.25 ml of a medium (50 mM Tris-HCl (ph 7.4), 5 mM $MnCl_2$, 20 µg/ml chymostatin, 40 µg/ml bacitracin, 4 µg/ml leupeptin, 5 µg/ml p-APMSF, 200 µg/ml BSA) at 22°C for 90 min. At the end of the incubation period, the contents were quickly filtered through a Blue Mat 11740 filter (pretreated with 0.1% polyethylenimine for 3 hours prior to use) by using SKATRON Cell Harvester. The filter was then washed with a washing buffer (50 mM Tris-HCl (pH 7.4), 5 mM $MnCl_2$). The

The following Preparations and Examples are given for the purpose of illustrating this invention.

Preparation 1

(2-Methoxyethoxy)methyl chloride (4.87 ml) was added to a solution of 3-hydroxy-4-methylbenzoic acid (2.16 g) and N,N-diisopropylethylamine (9.2 ml) in 1,2-dichloroethane (40 ml) at room temperature. The mixture was stirred under reflux for 24 hours. After removal of the solvent by evaporation, the residue was partitioned between aqueous diluted hydrochloric acid solution and ethyl acetate. The organic layer was separated and washed with brine, dried over magnesium sulfate and evaporated under reduced pressure. The crude oil was purified by column chromatography on silica gel using mixed solvents of hexane and ethyl acetate (3:1). The fractions containing the objective compound were collected and evaporated under reduced pressure to give (2-methoxyethoxy)methyl 3-[(2-methoxyethoxy)methoxy]-4-methylbenzoate (4.82 g) as an oil.

IR (Neat) : 1725, 1595 cm^{-1}

NMR ($CDCl_3$, δ) : 2.29 (3H, s), 3.37 (3H, s), 3.39 (3H, s), 3.54-3.90 (8H, m), 5.35 (2H, s), 5.60 (2H, s), 7.21 (1H, d, J=8.0Hz), 7.65 (1H, dd, J=1.6 and 8.0Hz), 7.74 (1H, d, J=1.4Hz)

MASS (API-ES) : 351 $(M+Na)^+$

Preparation 2

Lithium aluminum hydride (0.35 g) was added by small portions over 12 minutes to an ice-cooled solution of (2-methoxyethoxy)methyl 3-[(2-methoxyethoxy)methoxy]-4-methylbenzoate (3.5 g) in tetrahydrofuran (20 ml) below 5°C under nitrogen atmosphere. After the mixture was stirred at the same temperature for 30 minutes, 2N sodium hydroxide (0.5 ml) was added to the mixture. After the mixture was stirred for 30 minutes, the insoluble materials were removed by

collected and evaporated under reduced pressure to give 1-acetyl-3-[3-[(2-methoxyethoxy)methoxy]-4-methylphenyl]-methylene-2,5-piperazinedione (2.05 g) as a powder.

IR (KBr) : 3208, 1700, 1627, 1598, 1455, 1375 cm^{-1}

NMR ($CDCl_3$, δ) : 2.26 (3H, s), 2.65 (3H, s), 3.27 (3H, s), 3.58-3.62 (2H, m), 3.81-3.86 (2H, m), 4.49 (2H, s), 5.32 (2H, s), 6.94 (1H, dd, J=1.5 and 7.8Hz), 7.15 (1H, d, J=7.8Hz), 7.23 (1H, d, J=1.5Hz), 7.27 (1H, s), 8.34 (1H, br s)

MASS (API-ES) : 417 $(M+MeOH+Na)^+$

Preparation 4

A solution of 1-acetyl-3-[[3-[(2-methoxyethoxy)methoxy]-4-methylphenyl]methylene]-2,5-piperazinedione (2.0 g) in tetrahydrofuran (20 ml) was hydrogenated over 10% palladium-carbon (50% wet, 0.2 g) at room temperature under atmospheric pressure for 3 hours. After removal of the catalyst by filtration, the filtrate was concentrated under reduced pressure. The resulting residue was dissolved into tetrahydrofuran (30 ml) and thereto was added hydrazine monohydride (1.5 ml). After being stirred for 1 hour at room temperature, the mixture was concentrated under reduced pressure. The residue was triturated with isopropyl alcohol and the resulting solid was collected by filtration to give 3-[3-[(2-methoxyethoxy)methoxy]-4-methylbenzyl]-2,5-piperazinedione (1.75 g).

IR (KBr) : 3183, 3060, 1675, 1454 cm^{-1}

NMR ($CDCl_3$, δ) : 2.21 (3H, s), 2.95-4.00 (8H, m), 3.36 (3H, s), 4.20-4.27 (1H, m), 5.19 (1H, d, J=7.0Hz), 5.38 (1H, d, J=7.0Hz), 6.50 (1H, br s), 6.72 (1H, br s), 6.75 (1H, dd, J=1.4 and 7.9Hz), 6.97 (1H, d, J=1.4Hz), 7.08 (1H, d, J=7.9Hz)

MASS (APCI) : 323 $(M+H)^+$, 247, 235

Preparation 5

(17H, m), 6.40-8.10 (10H, m), 7.82 (1H, br s)

MASS (APCI) : 669 $(M+H)^+$

Preparation 6

A solution of 1-[3,5-bis(trifluoromethyl)benzoyl]-4-(benzyloxycarbonyl)-2-[3-[(2-methoxyethoxy)methoxy]-4-methylbenzyl]piperazine (1.6 g) in methanol (20 ml) was hydrogenated over 10% palladium-carbon (50% wet, 0.2 g) at room temperature under atmospheric pressure for 4 hours. After removal of the catalyst by filtration, the filtrate was concentrated under reduced pressure. The residue was purified by column chromatography on silica gel using mixed solvents of dichloromethane and methanol (40:1). The fractions containing the objective compound were collected and evaporated under reduced pressure to give 1-[3,5-bis(trifluoromethyl)benzoyl]-2-[3-[(2-methoxyethoxy)methoxy]-4-methylbenzyl]piperazine (0.89 g) as an oil.

IR (Neat) : 1732, 1714, 1705, 1647, 1431 cm^{-1}

NMR ($CDCl_3$, δ) : 2.20 (3H, s), 2.50-5.20 (16H, m), 3.00 (3H, s), 6.40-7.40 (5H, m), 7.80 (1H, s)

MASS (API-ES) : 557 $(M+Na)^+$, 535 $(M+H)^+$

Preparation 7

To a mixed solution of (3R)-3-methoxymethylmorpholine hydrochloride (4.71 g) and triethylamine (4.11 ml) in methanol (110 ml) was added 5.8M ethylene oxide (22 ml) in toluene solution at room temperature. After the reaction mixture was stirred at the same temperature for two days, it was evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using mixed solvents of dichloromethane and methanol (20:1). The fractions containing the objective compound were collected and evaporated under reduced pressure to give 2-[(3R)-3-methoxymethylmorpholino]ethanol (4.67 g) as an oil.

IR (Neat) : 3433, 2860, 1454, 1119, 1055 cm^{-1}

To an ice-cooled solution of 2-[(3R)-3-methoxymethylmorpholino]ethanol (505 mg) in toluene (2.5 ml) was added dropwise a solution of thionyl chloride (429 mg) in toluene (1.5 ml) below 5°C under nitrogen atmosphere. The mixture was stirred at 70°C for 1.5 hours. After the mixture was cooled at room temperature, ethyl acetate was added to the mixture, and resulting suspension was evaporated under reduced pressure. Diisopropyl ether was added to the residue, and after the mixture was stirred at room temperature for 15 minutes, the resulting precipitates were collected by filtration, washed with diisopropyl ether and dried at 40°C under reduced pressure to give (3R)-4-(2-chloroethyl)-3-methoxymethylmorpholine hydrochloride (620 mg) as a light yellowish powder.

mp : 162-163°C

IR (KBr) : 2945, 1140, 1109, 1084 cm^{-1}

NMR (DMSO-d_6, δ) : 3.31 (3H, s), 3.10-4.10 (13H, m)

MASS (APCI) : 194 $(M+H)^+$ (free)

Preparation 10

The following compounds were obtained according to a similar manner to that of Preparation 9.

(1) cis-2,6-Dimethyl-4-(2-chloroethyl)morpholine hydrochloride

IR (KBr) : 1513, 1458, 1394, 1336, 1143 cm^{-1}

NMR (DMSO-d_6, δ) : 1.12 (6H, d, J=6.3Hz), 2.60-2.80 (2H, m), 3.44-3.50 (4H, m), 3.95-4.10 (4H, m)

MASS (APCI) : 178 $(M+H)^+$ (free)

(2) (2S,5S)-4-(2-Chloroethyl)-2-methoxymethyl-5-methylmorpholine hydrochloride

IR (KBr) : 2613, 1456, 1390, 1124, 1082 cm^{-1}

NMR (DMSO-d_6, δ) : 1.13 (3H, d, J=6.3Hz), 2.50-3.00 (3H, m), 3.27 (3H, s), 3.34-3.51 (7H, m), 4.03-4.10

under reduced pressure. The residue was purified by column chromatography on silica gel using mixed solvents of dichloromethane and methanol (30:1). The fractions containing the objective compound were collected and evaporated under reduced pressure to give (2S)-2-[N-benzyl-N-[(2S)-2-hydroxy-3-methoxypropyl]amino]-1-propanol (10.4 g) as an oil.

IR (Neat) : 3400, 2929, 1452, 1414, 1373, 1329 cm^{-1}

NMR ($CDCl_3$, δ) : 0.96 (3H, d, J=6.7Hz), 2.50-2.60 (1H, m), 2.57 (1H, dd, J=13.4 and 6.2Hz), 2.67 (1H, dd, J=13.4 and 6.5Hz), 2.95-3.10 (1H, m), 3.21-3.52 (4H, m), 3.30 (3H, s), 3.49 (1H, d, J=13.6Hz), 3.71-3.75 (1H, m), 3.83 (1H, d, J=13.6Hz), 7.21-7.37 (5H, m)

MASS (APCI) : 254 $(M+H)^+$

Preparation 13

Triphenylphosphine (10.09 g) was added to a solution of (2S)-2-[N-benzyl-N-[(2S)-2-hydroxy-3-methoxypropyl]amino]-1-propanol (8.86 g) in tetrachloromethane (4.06 ml) at room temperature. After being stirred at room temperature for 2 days, the solution was concentrated under reduced pressure. The residue was triturated with diisopropyl ether (200 ml) three times, and the soluble portions were separated by decantation and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using mixed solvents of dichloromethane and methanol (40:1). The fractions containing the objective compound were collected and evaporated under reduced pressure to give (2S)-1-[N-benzyl-N-[(1S)-2-chloro-1-methylethyl]amino]-3-methoxy-2-propanol (4.90 g) as an oil.

IR (Neat) : 3463, 1452, 1362 cm^{-1}

NMR ($CDCl_3$, δ) : 1.43 (3H, d, J=6.6Hz), 2.53-2.82 (4H, m), 3.30-3.39 (2H, m), 3.36 (3H, s), 3.59 (1H, d, J=13.6Hz), 3.83 (1H, d, J=13.6Hz), 3.79-3.87 (1H,

IR (Neat) : 3433, 3402, 2939, 1597, 1456, 1392, 1331, 1107 cm^{-1}

NMR (DMSO-d_6, δ) : 1.12 (3H, d, J=6.3Hz), 2.49-2.75 (2H, m), 3.13-3.19 (2H, m), 3.27 (3H, s), 3.38 (2H, d, J=4.8Hz), 3.80-4.00 (2H, m)

MASS (APCI) : 146 $(M+H)^+$ (free)

Preparation 16

N-Acetyl-3-methoxy-4-methyl-DL-phenylalanine (7.28 g) was dissolved into a mixture of water (36.5 ml) and 1N sodium hydroxide solution (29 ml). Cobalt(II) chloride hexahydrate (36.5 mg) and acylase (Acylase Amano, 365 mg) were added to the solution and the mixture was stirred at 37°C for 15.5 hours with controlling the pH of the reaction mixture to 7.5 with 1N sodium hydroxide solution. The insoluble material was removed by filtration and the pH of the filtrate was made to 3 with 6N hydrochloric acid, extracted with ethyl acetate, washed with water, dried over sodium sulfate, and evaporated in vacuo to give crude N-acetyl-3-methoxy-4-methyl-D-phenylalanine (3.17 g). The crude product was again subjected to the acylase reaction (cobalt(II) chloride hexahydrate 15.2 mg, acylase 152 mg, 37°C, pH 7.5, 20 hours) to give pure N-acetyl-3-methoxy-4-methyl-D-phenylalanine (2.70 g) as a viscous oil.

$[\alpha]_D^{26.8}$: -36.16° (C=0.424, MeOH)

IR (Neat) : 3350, 1740, 1725 cm^{-1}

NMR ($CDCl_3$, δ) : 1.99 (3H, s), 2.17 (3H, s), 3.00-3.25 (2H, m), 4.75-4.90 (1H, m), 6.00-7.10 (3H, m), 6.36 (2H, br s)

MASS (APCI) : 252 $(M+H)^+$

Preparation 17

A mixture of N-acetyl-3-methoxy-4-methylphenyl-D-alanine (2.55 g) in a mixture of 6N hydrochloric acid (25.5 ml) and toluene (18 ml) was stirred under reflux for 4 hours. After

J=1.4 and 7.6Hz), 6.87 (1H, d, J=1.4Hz), 7.22 (1H, d, J=7.6Hz)

MASS (APCI) : 224 $(M+H)^+$ (free), 207, 164

Preparation 19

Potassium carbonate (1.70 g) was added by small portions with ice-cooling to a mixture of 3-methoxy-4-methyl-D-phenylalanine methyl ester hydrochloride (1.60 g) in mixed solvents of dichloromethane (7 ml) and water (9 ml). Chloroacetyl chloride (0.66 ml) was added to the mixture below 5°C over 15 minutes and then the whole was stirred for 30 minutes. The organic layer was separated, washed with brine, dried over magnesium sulfate and evaporated under reduced pressure to give an oil of (2R)-2-[N-(chloroacetyl)-amino]-3-(3-methoxy-4-methylphenyl)propionic acid methyl ester.

IR (Neat) : 3305, 1737, 1643, 1583 cm^{-1}

Preparation 20

Benzylamine (1.65 g) and potassium carbonate (1.28 g) were added successively to a solution of (2R)-2-[N-(chloroacetyl)amino]-3-(3-methoxy-4-methylphenyl)propionic acid methyl ester (1.85 g) in N,N-dimethylformamide (15 ml) at 20°C. After being stirred at 35°C for 1.5 hours, the mixture was poured into a mixture of ice-water (20 ml) and dichloromethane (20 ml). After the mixture was adjusted to pH 9 with diluted aqueous hydrochloric acid under stirring, the organic layer was separated, washed with brine (20 ml), dried over magnesium sulfate and evaporated under reduced pressure to give an oil of (2R)-2-[N-(benzylacetyl)amino]-3-(3-methoxy-4-methylphenyl)propionic acid methyl ester.
A solution of (2R)-2-[N-(benzylacetyl)amino]-3-(3-methoxy-4-methylphenyl)propionic acid methyl ester obtained by above procedure and acetic acid (0.18 ml) in isopropyl alcohol (10 ml) was stirred for 12 hours under reflux.

5°C. After being stirred for 30 minutes at the same temperature, the reaction mixture was washed with brine, dried over magnesium sulfate and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using mixed solvents of hexane and ethyl acetate (4:1). The fractions containing the objective compound were collected and evaporated under reduced pressure to give (2R)-4-benzyl-1-[3,5-bis(trifluoromethyl)benzoyl]-2-(3-methoxy-4-methylbenzyl)piperazine (1.92 g) as an oil.

IR (Neat) : 2950, 2850, 1640, 1590, 1515 cm^{-1}

NMR ($CDCl_3$, δ) : 2.16 (3H, s), 2.00-5.20 (14H, m), 6.25-6.32 (1H, m), 6.70-6.90 (2H, m), 7.20-7.44 (7H, m), 7.80 (1H, br s)

MASS (APCI) : 551 $(M+H)^+$, 573 $(M+Na)^+$

Preparation 22

A solution of boron tribromide in dichloromethane (1M solution, 3.7 ml) was added dropwise over 20 minutes to an ice-cooled solution of (2R)-4-benzyl-1-[3,5-bis(trifluoromethyl)benzoyl]-2-(3-methoxy-4-methylbenzyl)-piperazine (0.68 g) in dichloromethane (5 ml). After being stirred at the same temperature for 2 hours, followed by further stirring at room temperature for 12 hours, the mixture was poured into aqueous saturated sodium hydrogen carbonate solution. The organic layer was separated, dried over magnesium sulfate and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using mixed solvents of hexane and ethyl acetate (4:1). The fractions containing the objective compound were collected and evaporated under reduced pressure to give (2R)-4-benzyl-1-[3,5-bis(trifluoromethyl)benzoyl]-2-(3-hydroxy-4-methylbenzyl)piperazine (0.56 g) as a red foam.

IR (Neat) : 1630, 1430 cm^{-1}

NMR ($CDCl_3$, δ) : 2.00-5.20 (14H, m), 5.61 (1H, br s), 6.20-6.25 (1H, m), 6.60-7.70 (2H, m), 7.20-7.60

solvents of dichloromethane and methanol (30:1). The fractions containing the objective compound were collected and evaporated under reduced pressure to give (2R)-1-[3,5-bis(trifluoromethyl)benzoyl]-2-[3-[(2-methoxyethoxy)methoxy]-4-methylbenzyl]piperazine (0.32 g) as an oil.

IR (KBr) : 3000-2700, 1629, 1513, 1444 cm^{-1}

NMR ($CDCl_3$, δ) : 2.20 (3H, s), 2.50-5.30 (16H, m), 3.36 (3H, s), 6.40-7.50 (5H, m), 7.80 (1H, s)

MASS (API-ES) : 535 $(M+H)^+$, 557 $(M+Na)^+$

Example 1

To a solution of 1-[3,5-bis(trifluoromethyl)benzoyl]-2-[3-[(2-methoxyethoxy)methoxy]-4-methylbenzyl]piperazine (440 mg) in N,N-dimethylformamide (2.2 ml) were added (3R)-4-(2-chloroethyl)-3-methoxymethylmorpholine hydrochloride (289 mg), potassium carbonate (434 mg) and potassium iodide (149 mg) at room temperature. The whole was stirred at 73°C for 2 hours. After being cooled to room temperature, the mixture was poured into ice-water and the aqueous mixture was made alkaline with saturated aqueous sodium hydrogen carbonate solution. The resulting mixture was extracted with ethyl acetate. The extract was washed with brine, dried over sodium sulfate and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using mixed solvents of dichloromethane and methanol (40:1). The fractions containing the objective compound were collected and evaporated under reduced pressure to give 1-[3,5-bis(trifluoromethyl)benzoyl]-2-[3-[(2-methoxyethoxy)-methoxy]-4-methylbenzyl]-4-[2-[(3R)-3-methoxymethyl-morpholino]ethyl]piperazine (450 mg) as a light yellowish oil.

IR (Neat) : 2879, 1639, 1437, 1281, 1136, 1009 cm^{-1}

NMR ($CDCl_3$, δ) : 2.20 (3H, s), 1.95-5.40 (34H, m), 6.40-8.10 (6H, m)

MASS (APCI) : 692 $(M+H)^+$

over sodium sulfate and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using mixed solvents of dichloromethane and methanol (30:1). The fractions containing the objective compound were collected and evaporated under reduced pressure, and the residue was treated with 4N hydrogen chloride in ethyl acetate solution to give 1-[3,5-bis(trifluoromethyl)benzoyl]-2-[3-hydroxy-4-methylbenzyl]-4-[2-[(3R)-3-methoxymethylmorpholino]ethyl]piperazine dihydrochloride (280 mg) as a colorless powder.

mp : 167-172°C

$[\alpha]_D^{28}$: -8.50° (C=0.20, MeOH)

IR (KBr) : 3400, 1645, 1429, 1282, 1184, 1138 cm^{-1}

NMR (DMSO-d_6, δ) : 2.08 (3H, s), 2.60-5.10 (25H, m), 6.18-7.10 (3H, m), 7.36-8.22 (3H, m), 9.25 (1H, br)

MASS (APCI) : 604 $(M+H)^+$ (free)

Example 4

The following compounds were obtained according to a similar manner to that of Example 3.

(1) 1-[3,5-Bis(trifluoromethyl)benzoyl]-4-[2-(cis-2,6-dimethylmorpholino)ethyl]-2-(3-hydroxy-4-methylbenzyl)piperazine dihydrochloride

mp : 188-200°C

$[\alpha]_D^{29}$: +0.70° (C=0.25, MeOH)

IR (KBr) : 3402, 1643, 1516, 1429 cm^{-1}

NMR (DMSO-d_6, δ) : 1.15 (6H, d, J=6.0Hz), 2.08 (3H, br s), 2.00 -5.10 (19H, m), 6.19-8.21 (6H, m)

MASS (APCI) : 588 $(M+H)^+$ (free)

(2) 1-[3,5-Bis(trifluoromethyl)benzoyl]-2-(3-hydroxy-4-methylbenzyl)-4-[2-[(2S,5S)-2-methoxymethyl-5-methylmorpholino]ethyl]piperazine dihydrochloride

mp : 214-218°C

2.40-5.10 (22H, m), 6.19-8.22 (6H, m)

MASS (APCI) : 604 $(M+H)^+$ (free)

Example 6

A mixture of 1-[3,5-bis(trifluoromethyl)benzoyl]-2-[3-[(2-methoxyethoxy)methoxy]-4-methylbenzyl]piperazine (0.4 g), 1-chloro-3-(3-pyridyl)-2-propyne hydrochloride (0.17 g), potassium carbonate (0.52 g) and a trace of potassium iodide in N,N-dimethylformamide (7 ml) was stirred for 4 hours at 80°C. After cooling, the solvent was removed by evaporation, and ethyl acetate and aqueous sodium hydrogen carbonate solution were added thereto. The organic layer was separated, dried over magnesium sulfate, and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel using ethyl acetate. The fractions containing the objective compound were collected and evaporated under reduced pressure to give 1-[3,5-bis(trifluoromethyl)benzoyl]-2-[3-[(2-methoxyethoxy)methoxy]-4-methylbenzyl]-4-[3-(3-pyridyl)-2-propynyl]piperazine (0.44 g) as an oil.

NMR ($CDCl_3$, δ) : 0.60-5.60 (23H, m), 6.30-8.90 (10H, m)

MASS (APCI) : 650 $(M+H)^+$

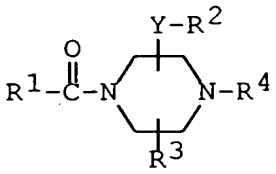
Example 7

A solution of 1-[3,5-bis(trifluoromethyl)benzoyl]-2-(3-hydroxy-4-methylbenzyl)-4-[3-(3-pyridyl)-2-propynyl]-piperazine (0.11 g) in methanol (10 ml) was treated with 4N hydrogen chloride in ethyl acetate (1 ml) and the mixture was evaporated under reduced pressure. The residue was triturated with a mixture of dichloromethane and ethyl acetate and the resulting powder was collected by filtration to give 1-[3,5-bis(trifluoromethyl)benzoyl]-2-(3-hydroxy-4-methylbenzyl)-4-[3-(3-pyridyl)-2-propynyl]piperazine dihydrochloride (0.07 g).

mp : 180-190°C

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A compound of the formula :



wherein
Y is bond or lower alkylene,
R^1 is aryl which may be substituted with suitable substituent(s),
R^2 is aryl or indolyl, each of which may be substituted with suitable substituent(s),
R^3 is hydrogen or lower alkyl,
R^4 is (3-pyridyl)methyl;
(3-pyridyl)ethyl;
3-(3-pyridyl)propyl;
3-(3-pyridyl)propenyl;
3-(3-pyridyl)propynyl;
pyrazolylmethyl which may be substituted with hydroxy(lower)alkyl;
pyrazolyl(lower)alkyl which is substituted with lower alkyl,
(lower)alkoxy(lower)alkylmorpholinyl(lower)alkyl or
(lower)alkoxy(lower)alkylmorpholinylcarbonyl-(lower)alkyl;
piperidylmethyl;
piperidyl(lower)alkyl which is substituted with lower alkyl or
(lower)alkoxy(lower)alkyl;
(2,6-dimethylmorpholino)(lower)alkyl;
(3,3-dimethylmorpholino)(lower)alkyl;

of lower alkyl, mono(or di or tri)halo(lower)alkyl, halogen, lower alkylenedioxy, lower alkoxy(lower)alkoxy(lower)alkoxy, hydroxy, hydroxy(lower)alkyl, cyano, pyrrolidinyl and morpholinyl which may be substituted with lower alkoxy(lower)alkyl or lower alkyl or indolyl;

R^3 is hydrogen; and

R^4 is 3-(3-pyridyl)propyl;
3-(3-pyridyl)propynyl;
(2,6-dimethylmorpholino)(lower)alkyl;
(3,3-dimethylmorpholino)(lower)alkyl;
(cis-3,5-dimethylmorpholino)(lower)alkyl;
((3S,5S)-3,5-dimethylmorpholino)(lower)alkyl;
(2-methoxymethylmorpholino)(lower)alkyl;
(3-methoxymethylmorpholino)(lower)alkyl;
(2-methoxymethyl-5-methylmorpholino)(lower)alkyl;
(2-methoxymethyl-5,5-dimethylmorpholino)(lower)-alkyl;
(3,5-dimethoxymethylmorpholino)(lower)alkyl;
(2,3-dimethoxymethylmorpholino)(lower)alkyl; or
(2-methoxymethylmorpholino)(lower)alkenyl.

3. A compound of claim 2, which is selected from the group consisting of

(1) 1-[3,5-Bis(trifluoromethyl)benzoyl]-2-[3-hydroxy-4-methylbenzyl]-4-[2-[(3R)-3-methoxymethylmorpholino]-ethyl]piperazine,

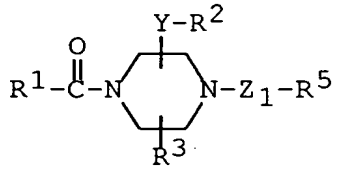
(2) 1-[3,5-Bis(trifluoromethyl)benzoyl]-4-[2-(cis-2,6-dimethylmorpholino)ethyl]-2-(3-hydroxy-4-methylbenzyl)piperazine,

(3) 1-[3,5-Bis(trifluoromethyl)benzoyl]-2-(3-hydroxy-4-methylbenzyl)-4-[2-[(2S,5S)-2-methoxymethyl-5-methylmorpholino]ethyl]piperazine,

(4) 1-[3,5-Bis(trifluoromethyl)benzoyl]-2-(3-hydroxy-4-methylbenzyl)-4-[3-(3-pyridyl)-2-propynyl]piperazine,

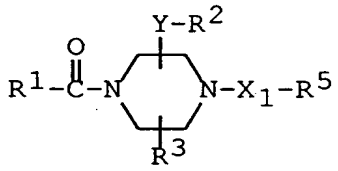
wherein R^1, R^2, R^3, R^4 and Y are each as defined in claim 1,
or a salt thereof, or

(2) subjecting a compound of the formula (Ia) :



(Ia)

wherein R^1, R^2, R^3 and Y are each as defined above,
R^5 is 3-pyridyl, and
Z_1 is lower alkynylene,
or a salt thereof to a reduction reaction to give a compound of the formula (Ib) :



(Ib)

wherein R^1, R^2, R^3, Y and R^5 are each as defined above, and
X_1 is lower alkylene,
or a salt thereof.

5. A pharmaceutical composition which comprises, as an active ingredient, a compound of calim 1 or a pharmaceutically acceptable salt thereof in admixture with pharmaceutically acceptable carriers.

6. A compound of calim 1 for use as a medicament.

7. A method for treating or preventing Tachykinin-mediated